THEORETICAL MODELS AND RELEVANT CALCULATIONS OF PHOTON PRODUCTION AND PHOTONUCLEAR REACTION DATA

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Photon production and photonuclear reaction data, with emphasis to theoretical model aspects aimed to reliable evaluations, represent a challenge in many technological applications, from radiation shielding for different nuclear, including accelerator, systems to devices relevant to nuclear energy applications, particularly the ones concerning the Accelerator Driven Systems for nuclear waste transmutation.

In fact, theoretical calculations complementing the existing experimental data, mainly when the measured quantities are discrepant, scarce or even lacking, play an essential role in performing valuable nuclear data evaluations in this field of applied science. In this framework, new improved results of theoretical and evaluation activities carried out at ENEA, Division for Advanced Physics Technologies, are presented, especially concerning photon production data, from neutron induced reactions up to 20 MeV, and photonuclear reaction cross sections.

In this framework, relevant aspects of nuclear structure models and of evaporation and pre-equilibrium mechanisms are discussed together with a critical analysis of the related computing codes considered in present ENEA evaluations, aimed to produce specific contributions to the above mentioned nuclear programs and applications, and to co-operate in the framework of the international initiatives and efforts on the inter-comparison of the evaluated data and the relevant models and codes. Particularly, an innovative method has been developed and utilized for microscopic and statistical models of nuclear structure, especially referring to algebraic models and to superfluid models, in order to complement the adopted multi-step reaction model, as an unified framework for the treatment of pre-equilibrium and compound-nucleus processes. Moreover, microscopic algebraic model calculations are discussed , as they have been brought up to predict photonuclear reaction data in the present context.

Most significant results are presented from calculations relevant to some innovative structural materials in nuclear applications, namely Ti, V and Mo isotopes, in comparison with the presently available experimental values. Moreover, with regard to heavy nuclei reaction data, the effect of photo-fission channel is discussed for U and Th nuclides of main relevance, in a simple yet reliable model of statistical fission.

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